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product quality and service quality

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**CORE**

DISCUSSION PAPER

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and Econometrics

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**Price differentials among brands in retail distribution:  
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**Abstract**

We develop a theoretical model of retail competition that include two sources of quality, one inherently linked to brand characteristics and the other linked to the retailer level of service. We then measure their contribution in explaining the observed price differentials for a sample of U.K. grocery retailer prices in the south of Coventry during the period November 1995 to March 1997. We find that retailers that offer a higher quality service sell same quality brands at higher prices. These price premia are explained solely by differences in service quality levels. We find econometric evidence that they amount to 6 percent for national brands and to a range between 9 percent and 15 percent for low-quality store brands. Besides, at a given store, the price premia paid for the national brand is positive. These differentials are very large: around 150 percent between national brands and low-quality store brands, around 40 percent between national brands and high-quality store brands. Also, the price differential between the national brand and the low-quality store brand does not increase with its service quality. Besides, the price of the high-quality store brand approaches the price of the national brand when service quality increases. Thus suggesting that stores that offer high quality service uses the level of service as a strategic tool to target the leading national brand consumers.

**Keywords:** store brands, brand quality, service quality.

**JEL Classification:** C70, L13, J50, J52

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# 1 Introduction

The selling of simple products like food and household goods is becoming a very complex matter. Many business of different sort either store based (like supermarkets, convenience stores, departement stores), or non-store based (like internet retailing, home retailing) fight for customers, who are more concerned with price and quality in downturn economic periods. As a result, similar products are often sold at very different prices across the market. Both the quality and the brand name of the product as well as the service quality of a particular retailer will be important features to determine the final price. Our research aim is to develop a theoretical model of retail competition that include both sources of quality and then measure their contribution in explaining the observed price differentials for a sample of U.K. grocery retailers.

The retail industry is the second largest industry in the U.S.. According to the U.S. Bureau of Labor Statistics, 14.4 million people were employed in the U.S. retail industry as of April, 2010. Besides, the total amount of sales for the U.S. retail industry (including food service and automotive) was \$4.13 trillion, according to the latest annual report from the U.S. Census Bureau (calendar year 2009). Essentially, the retail sector facilitates the purchase by consumers of 27% of Domestic Final Demand, the goods and services sold to final purchasers. In the European Union, more than 30% of the enterprises was active in the distributive trade sector (composed of motor trade, wholesale trade, and retail trade and repair) and generated EUR 1,099 thousand million of value added in 2006, whilst providing employment for about 31.7 million persons. EUR 146 thousand million and 7 million employees come from the retail trade (see Europe in figures — Eurostat yearbook 2010).

The vast majority of all retail stores are single-store businesses, however these single-store businesses account for substantially less than half of all retail sales. The majority of the revenue in the retail industry is generated by companies that run retail "chains". This industry is becoming more concentrated and large retailers (e.g. Wal-Mart, Carrefour, Tesco, Metro) are included among the big actors in the nowadays economies. The biggest retailer in the world is Wal-Mart, which generated over \$344 billion in revenue in 2009. The retail industry can be divided into a number of smaller sectors or "sub-industries". In particular, it is split between store and non-store retailers. The first category is in turn split into grocery and non grocery retailers,<sup>1</sup> while in the second category retailers

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<sup>1</sup>This classification can be refined into more subdivisions as Department Stores (e.g. Macy's, Kohl's, J.C. Penney, Saks, Nordstrom, John Lewis, Selfridges, Harrods, Debenhams, El Corte Ingles, Galeries Lafayette), Discount Stores (e.g. Wal-Mart, Target, K-Mart, Costco, Sears) among the non-grocery retailers and supermarkets, hypermarkets, discounters, convenience stores and so on.

are classified attending to their type of sale, e.g. vending, internet retailing, and home shopping.

To undertake our analysis we focus on the U.K. grocery sector. The U.K. grocery market was worth £146.3 billion in 2009, which supposed an increase of 4.8 per cent over 2008. Groceries account for 12.8 percent of total household spending in the U.K., making it the third largest area of expenditure, following housing and transport. Food and grocery expenditures account for 52p in every £1.00 of retail spending (excluding restaurants). The industry is divided into four broad categories: a) convenience retailing (20,71% of the grocery market), b) traditional retail (4,44%), c) hypermarkets, supermarkets and superstores (72,32%); and d) on-line (2,53%) (source IGD). Category c) includes Asda, Morrisons, Sainsbury's and Tesco (the four largest supermarkets); 11 smaller chains such as Somerfield, Waitrose and Marks & Spencer; and 'discounters' such as Aldi, Lidl and Netto.<sup>2</sup> There are substantial differences in the scale, strategy and product offering of the different firms.

Grocery retailers are competing within a relatively mature market. Stable population limits growth of food consumption. Food expenditure (other than eating out) accounts for a declining share of household budgets. This has driven multiple retailers to fiercely compete for market share through multifold strategies as price, range and service; retailers have shifted to premium products, diversified into non-grocery products and services, enlarged existing stores and opened high-street convenience stores. That is, retailers' strategies include three relevant dimensions: 1) price, 2) brand quality competition, and 3) retailer differentiation. Regarding the price dimension, note that operation margins are usually low and there is a wide range of promotional price activity.<sup>3</sup> As for brand quality competition, customers weigh up quality of product and service against the money involved in buying groceries. In the recent years consumers are more concerned on healthy products, organic food and convenience (semi-prepared) food where quality is the driven force rather than price. Finally, retailers' differentiation strategies basically include location, the introduction of store-brands, the product line length and availability and the level of service or service quality.<sup>4</sup> Service quality includes shop ambience, aisle space,

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<sup>2</sup>The four biggest chains account for 67.9% of the grocery market. Tesco has 28% market share, followed by ASDA (15.2%), Sainsbury's (14.3%) and Morrison's (10.4%). After the Cooperative purchased Somerfield, this group now has 8% market share (Cooperative at 6.3% and Somerfield at 2.7%). Source GAIN Report UK Retail Food Sector 2009 and UK Supermarket Chain Profiles, USDA.

<sup>3</sup>Based on Office for National Statistics data, the OFT estimates that real prices for food fell by 7.3 % between January 2000 and December 2005. (see The grocery market: The OFT's reasons for making a reference to the Competition Commission, 2005)

<sup>4</sup>Responses to the consultation on the Office Fair Trade's Proposed Decision, particularly from individuals, made clear that access to a range of products of different stores (including independents) is valued

easy navigation, size of parking areas, queuing times, opening hours, number of credit and debit cards accepted and helpfulness of staff.

In particular, focusing in the differences between supermarkets chains and discounters, it is common to observe that discounters concentrate on the so called value items, i.e. low price and simple packaged goods. They offer less products and less service quality than the supermarket chains. Davies and Brito (2004) report that many discounters operate with as few as four full time equivalent staff per store compared with the 200 or more in a superstore. And also that a supermarket chain may offer 20,000 product lines while a discounter only 1,500.

Prior to empirically analysing the price differentials among brands, where data collected from the UK grocery industry are used, we propose a theoretical model that consists of the following. A supermarket and a discounter compete by choosing the output sold for its product line. Both firms are asymmetric with respect to some of their strategies. We assume that the supermarket sells three different brands, which are ranked in terms of brand quality: a national brand, a high-quality store brand and a low-quality store brand. The discounter, however, sells only two brands, a national brand and a low-quality store brand. Furthermore, the supermarket and the discounter provide a certain level of service quality that affects the consumers' willingness to pay for the brands sold in their stores. We solve for the Cournot quantity output equilibrium and compute the price differences among brands. We find that price premia across firms are explained by differences in service quality levels and they are independent of the brand type. Regarding price premia within a retailer, we find that price premia of the national brand over the low-quality store brand are increasing with the national brand level of quality and wholesale price and decreasing with the level of quality and marginal cost of the low-quality store brand. Therefore, those premia are firm independent. Further, as the supermarket service level increases the price premia of the national brand over the high-quality store brand decreases and thus increases the one of the high over the low-quality store brands. The effects of the discounter level of service are just the opposite. Basically, the supermarket level of service can be understood as a strategic tool to deal with competition with the leading national brands. In fact, a variation in the supermarket's service quality has the same qualitative effects as a variation in the high-quality store brand quality level on price premia, but the advantage of the former is that is better controlled by the retailer than the latter.

Regarding the empirical treatment, the data used in this analysis are prices directly collected by the authors in three stores in the south of Coventry, one from each of the first and second biggest supermarket chains in the UK at the time do data collection (Tesco

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by a significant number of consumers.

and Sainsbury's) and the large soft discounter (Kwik Save). The dataset is composed of 27 price observations for 46 products taken from November 1995 to March 1997 on a fortnightly basis (but for the Christmas periods). The criteria used to select the products for the sample are the following: i) they should be present in the grocery basket of the representative UK consumer, and ii) they should be available in all the three retailers in the sample. We find empirical support of the two testable implications of the theoretical model on service-quality premia. First, for a given quality, the price premia is the same for both supermarkets (since both offer the same service level). We find significant price differences of 6 percent in the national brand and between the 9 and 15 percent for the low-quality store brand. Further no significant differences are obtained between Tesco and Sainsbury's prices of the national brand and the low-quality store brand. The second testable implication is that for each retailer the service-quality premium is brand-quality independent. We test this implication by estimating the differentials in premium between Tesco and Kwik Save for the national brand and for the low-quality store brand, and the same between Sainsbury's and Kwik Save. Our finding is that for Tesco the hypothesis is supported, but for Sainsbury's there is a statistically significant difference in the price premia between brands. Regarding brand-quality premia, the theoretical model predicts that the price premia of the national brands over the low-quality store brands are firm independent. Our estimates yield a positive premia that ranks from 148 to 171 percent. Also, the theoretical testable implication is partially supported as we do not find significant differences between Tesco and Kwik Save premia although they are different in service quality. Finally, our estimates of the price premia of national brands over high-quality store brands yields positive differences that rank between 38 and 40 percent with no significant difference among supermarkets. Similarly, the price premia of the high over the low-quality store brand range from 80 to 87.5 percent and no significant differences across supermarkets.

Multiproduct retailer competition in brand quality has been dealt with basically through the competition between one national brand (high quality) and one store brand (low quality). Several papers address the effects of the introduction of a low quality brand. For example Scott Morton and Zettelmeyer (2004) study the reason why a retailer might prefer carrying a store brand rather than a national brand in its product line. They find that the ability of retailers to pinpoint the store brand positioning close to the leading national brand is the reason why retailers replace a second national brand with its store brand. Gabrielsen and Sørsgard (2007) analyse the effect of store brand introduction (or even the threat of introduction) on prices of the national brand. They find that, when exclusivity is conceded by a retailer, this is at expense of price concessions from

the national brand producer. However, if exclusivity is not achieved, i.e. a store brand is introduced, this lead to higher retail prices on national brands. Multiproduct retailer competition in service quality<sup>5</sup> has been considered to understand the effects of predation and of vertical restraints in welfare by Walsh and Whelan (1999) and Moner-Colonques (2006), respectively.<sup>6</sup> In Walsh and Whelan (1999), multi-product retailers first choose the level of services and then compete in prices. They show that under imperfections such as imperfect competition or imperfect information, predatory pricing by retailers can lead to higher welfare than second-best market intervention in the way of price controls by antitrust authorities due to the interaction between price and service. Also, Moner-Colonques (2006) models quantity and retail service competition between differentiated multi-product retailers to conclude that, when intra-brand and in-store competition are rather large, exclusivity leads to higher levels of service and welfare. Our paper contributes to the literature of multiproduct differentiated retail competition. It combines two different sources of quality differentiation, one coming from the brand characteristics and name and another coming from the level of consumer service offered by the seller; this allows us to find how the demand interactions among differently valued brands can explain price differences within and across multi-product retailers.

On the empirical side<sup>7</sup> our paper is related to Davies and Brito (2004). Their approach differ from ours in several respects. They adopt the value system perspective in their analysis.<sup>8</sup> Then, their goal is to explain the price differences that arise among competing value systems on a selected number of category products in the UK grocery industry. In contrast with us, they focus on data on the transfer prices of goods and services from

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<sup>5</sup>Models with one manufacturer and single product retailers competing in price and service include Caillaud and Rey (1986), for a competitive supply of retailers, Mathewson and Winter (1984), where retailers are spatially differentiated and Perry and Porter (1990), who consider a representative consumer model of demand to generate retail differentiation.

<sup>6</sup>Winter (1993) explores the relationship between vertical restraints and welfare in the case of spatially differentiated single-product retailers. He finds that, when retailers compete in prices and in services which reduces the time a consumer devotes to shopping, retailers are biased against service competition resulting in a suboptimal outcome. Either a price floor or exclusive territories are sufficient to restore the first-best.

<sup>7</sup>Testing the effect of quality on price differentials in the banana market, Wiggins and Raboy (1996) find that price premia associated with containerization (as a quality attribute) are quite robust and explain the bulk of inter-company price differences, whereas brand-name does not. Also, see Shepard (1991) for the gasoline retail market in eastern Massachusetts. She finds price differentials consistent with the price discrimination hypothesis and inconsistent with cost-driven differentials. On average, the price differential at multiproduct stations is 9 cents -11 cents higher than the differential across single-product stations. The higher differential comes largely from higher full-service prices.

<sup>8</sup>When a firm belongs to a superior form of organization, its competitive advantage is explained not only by its own value to the chain but also by how it fits within the organization. The relevant actor is the full organization not each member (see Porter, 1984).

one value chain member to another and on the costs added within each value chain by different elements such as production, marketing and logistics. They find on average a 42,6 percent price premium paid for national brands when compared with the store-brands sold by supermarkets.<sup>r</sup> The source of this price premium being the internal costs of brand manufacturers, in particular, marketing costs (i.e. consumer advertising and trade marketing), employment costs and R&D expenses. Also, the selling prices of store brands in discount stores were on average 17.9 percent lower than store brands in supermarkets. Once again the internal cost are the source of the price premia since they report that employee costs as a percentage of turnover in the leading British grocery retailer were 9.9 percent compared to 6.7 percent in the leading discount store operator. Also, that discounters have a faster stock turning than a supermarket so a similar return on capital can be achieved at lower gross margin and lower operating cost. Finally, regarding the relevance of product quality and brand image in explaining price differences they find that only in one product category was there a quality justification for the higher prices charged by the leading manufacturer brand. Although a straightforward comparison between their results and ours is difficult to assess, our estimates are particularly closer to theirs regarding the service-quality premia. We obtain a 15 percent increase of low-quality store-brands prices in supermarkets over the same brands sold by discounters. Also and regarding the price premia between national brands and store brands sold by supermarkets, we find higher differences when the low-quality brands are considered (between 148 percent and 171 percent), but similar when high-quality store brands are regarded, between 38 percent and 40 percent.

The next section sets out the theoretical model and delivers the results. Section 3 deals with the econometric model and the description of the dataset. Section 4 is focused on the estimation and the empirical conclusions and the final Section contains the conclusions.

## 2 The theoretical model

Consider an industry that produces three differentiated brands which are sold by two differentiated retailers. Consumers have maximum willingness to pay for each that depend on each brand quality level or brand name. Also, consumers show a different willingness to pay depending on which retailer is selling the brand. Further the three brands in the market are imperfect substitutes from each other.

Retailers are also differentiated regarding their product line breadth. There is one that offers the full product line of three brands, while the other only offers the highest and lowest qualities. Since we are focusing on the grocery market, it can be interpreted that the highest level of quality corresponds to the leading national brand, while the other



two correspond to store brands. Thus the retailer with the full product line is selling two qualities of store brands, while the other just the low quality one.<sup>9</sup> This implies that only five brands are available to consumers. As the scope of the paper is to analyse the short-run, e.g. price differentials, all long-run strategies (brand quality levels, service quality levels and product line choices) are, so far, considered as given.

To be more specific, let  $q_j^r$  be the quantity of brand of quality  $j$  sold by retailer  $r$ , where  $j = N, H, L$  and  $r = S, D$ . Subscripts  $N, H$  and  $L$  denote the national brand, the high-quality store brand and the low-quality store brand respectively. Also, subscripts  $S$  and  $D$  denote a supermarket and a discounter. Let  $q = (q_N^S, q_H^S, q_L^S, q_N^D, q_L^D)$  be the column vector of all the marketed brands. We consider a representative consumer who maximizes the following utility function:  $U(.) = \alpha'q - q'Mq + I$ , by choosing the level of consumption for each brand. Parameter  $I$  represents all other goods and has a price normalized to unity. The consumer's budget constraint is taken as  $m = pq + I$ , where  $p$  denotes the price vector. Column vector  $\alpha = (\alpha_N^S, \alpha_H^S, \alpha_L^S, \alpha_N^D, \alpha_L^D)$  denote the maximum willingness to pay for brands. We consider two basic features that explain the consumers willingness to pay, the brand quality attached to the product characteristics and the service quality related to the retailers' ones. We will assume that both sorts of effects enter additively in the definition of the maximum willingness to pay, that is,  $\alpha_j^r = b_j + x_r$ , where  $b_j$  and  $x_r$  read brand  $j$ 's quality level and retailer  $r$ 's service quality level, respectively.<sup>10</sup> Finally,

$$M = \begin{pmatrix} 1 & d & e & 1 & e \\ d & 1 & f & d & f \\ e & f & 1 & e & 1 \\ 1 & d & e & 1 & e \\ e & f & 1 & e & 1 \end{pmatrix}$$

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<sup>9</sup> An early contribution to the literature of endogenous product lines is Brander and Eaton (1984), which studied whether multiproduct sellers preferred to compete in a compartmentalized fashion with each firm focusing on a segment of the market, or head-to-head, with competition in every fraction of the market. Product line decisions are also studied in the address model approach by Martínez-Giralt and Neven (1988), Gilbert and Matutes (1993) and De Fraja (1993), where firms compete in non-price variables; number of outlets, qualities and location, respectively. See also Moner-Colonques et al. (2011) for a non-address approach with multiproduct firms in the context of vertical channel competition.

<sup>10</sup> There are two basic approaches to quality (vertical) differentiation. One developed by Musa and Rosen (1978) the other by Gabszewicz and Thisse (1979), where consumers have identical preferences but different incomes. Higher-income individuals have a higher willingness to pay for quality. The price marginal effects on each demand depend on quality levels. In Musa and Rosen (1978) in a symmetric way while asymmetrically in Gabszewicz and Thisse (1979). We adopt a different approach as all the quality attributes are included in the demands' intercepts this just meaning that a higher quality product has a higher willingness to pay. The advantage of this approach is that it can combine vertical and horizontal differentiation in a simple way.

is the symmetric matrix that includes the different degrees of substitution among brands in the inverse demand functions. That is,  $d$  is the degree of substitution between the national brand and the high-quality store brand,  $e$  is the equivalent for the national brand and the low-quality store brand and, finally,  $f$  is the degree of substitution between the high and low-quality store brands. Note that brands of the same type and sold by different retailers will affect prices in the same manner. Throughout the paper we are going to assume that  $1 > d > f > e$ , which is interpreted as the national brand and the high-quality store brand are the closest substitutes and that the highest differentiation is between the national brand and the low-quality store brand. The system of inverse demand functions reads,

$$\begin{aligned} p_N^S &= \alpha_N^S - q_N^S - q_N^D - dq_H^S - e(q_L^S + q_L^D) \\ p_H^S &= \alpha_H^S - d(q_N^S + q_N^D) - q_H^S - f(q_L^S + q_L^D) \\ p_L^S &= \alpha_L^S - e(q_N^S + q_N^D) - f q_H^S - q_L^S - q_L^D \\ p_N^D &= \alpha_N^D - q_N^S - q_N^D - dq_H^S - e(q_L^S + q_L^D) \\ p_L^D &= \alpha_L^D - e(q_N^S + q_N^D) - f q_H^S - q_L^S - q_L^D. \end{aligned}$$

Retailers compete in the market by choosing outputs so as to maximize the following profits:  $R^S = (p_N^S - w_N)q_N^S + (p_H^S - c_H)q_H^S + (p_L^S - c_L)q_L^S$ ;  $R^D = (p_N^D - w_N)q_N^D + (p_L^D - c_L)q_L^D$ . For the sake of the exposition, we consider that retailers' marginal cost only includes the price at which they buy the product from manufacturers and, therefore, all other distribution costs are assumed to be zero. The supermarket and the discounter are selling products manufactured by the leading national brand producer and store brands that they obtain from a competitive sector of manufacturers. Therefore,  $w_N$  denotes the wholesale price for the national brand, while  $c_H$  and  $c_L$  denote the marginal costs for the store brands. It is assumed that  $w_N > c_H > c_L$ .

The first order conditions are obtained and correspond with the following system of equations:  $\hat{\alpha} = Aq$ , where  $\hat{\alpha}$  is the maximum willingness to pay net of retailer's marginal costs column vector, and  $A$  is the matrix the includes marginal effects of each marketed brand on retailers' marginal profits. The equilibrium vector is  $q^* = A^{-1}\hat{\alpha}$ , where equilibrium outputs are function of all the relevant parameters. Both  $A$  and  $A^{-1}$  and the equilibrium output expressions are in the Appendix 3.

*Result 1. Equilibrium output comparative statics:*

	$(b_N - w_N)$	$(b_H - c_H)$	$(b_L - c_L)$	$x_S$	$x_D$
$q_N^{S*}$	+	−	±	+	−
$q_H^{S*}$	−	+	−	±	0
$q_L^{S*}$	±	−	+	+	−
$q_N^{D*}$	+	0	−	−	+
$q_L^{D*}$	−	0	+	−	+

where two cases are distinguished,

- i) if  $1 + e < f + d$ , then both  $\frac{\partial q_N^{S*}}{\partial(b_L - c_L)}$  and  $\frac{\partial q_L^{S*}}{\partial(b_N - w_N)}$  are positive, while  $\frac{\partial q_H^{S*}}{\partial x_S}$  is negative;
- ii) if  $f + d < 1 + e$  then  $\frac{\partial q_H^{S*}}{\partial x_S} > 0$ , while  $\frac{\partial q_N^{S*}}{\partial(b_L - c_L)}$  and  $\frac{\partial q_L^{S*}}{\partial(b_N - w_N)}$  have an ambiguous sign.

In view of the above result, the brand quality and service quality effects are as expected in almost all the cases. That is, the equilibrium output of brand  $j$  sold by retailer  $r$  is increasing with brand quality  $j$  and service quality  $r$  and decreasing on all the others. There are two kinds of exceptions. Firstly, the discounter's equilibrium outputs are independent of the high-quality store brand and similarly the high-quality store brand output is independent of the discounter's service quality. Finally, there are unexpected positive signs regarding the cross effect of the national brand quality on the low quality store brand equilibrium output and viceversa, and a negative sign on the effect of the supermarket's service quality on the high-quality store brand equilibrium output. This occurs when  $e$ , the degree of substitution among the national brand and the low quality store brand, is quite smaller than  $f$ , the degree of substitution between the high and low-quality store brands.<sup>11</sup> Or equivalently a higher variance drawn on the substitution effects accross brands. To explain how the output of the high-quality store brand can decrease with the supermarket service note that an increase in service increases the willingness to pay (so, inverse demands shift outwards) for the supermarket brands. This is a direct effect that has to be balanced with indirect effects on the high-quality store brand inverse demand due to the increase on outputs of the other two brands sold by the supermarket. Definitely, which one of the effects dominate depends on the complex pattern of substitution across brands. A low  $e$  together with large  $f$  and  $d$  implies precisely that the indirect effect outweighs the direct effect for brand  $H$ . In other words, the supermarket brand  $H$ 's marginal revenue evaluated at the equilibrium output levels for the other brands shifts inwards if and only if  $1 + e < f + d$ .

<sup>11</sup>It is also required a large enough  $f$  and  $d$ , i.e.  $f + d > 1$ , to find positive values of  $e$  that satisfy the condition.

Now we compute price differentials at equilibrium by substituting  $q^*$  in the corresponding demand functions. It is easy to check that the difference in prices across retailers for the same brand type is precisely the difference in service, therefore  $p_N^{S*} - p_N^{D*} = p_L^{S*} - p_L^{D*} = x_S - x_D$ . Therefore, we can state our first testable implication for service-quality premia: *only service quality differentials are explaining price differences across retailers.*

Regarding price differentials within the same retailer, we find that the price premia for the national brand with respect to the low-quality store brand is explained by both the differences in quality and the differences in costs. This is true no matter what is the considered retailer:  $p_N^{S*} - p_L^{S*} = p_N^{D*} - p_L^{D*} = \frac{1}{3}(b_N - b_L) + \frac{2}{3}(w_N - c_L)$ . Then a second testable implication is obtained: *price premia of national brands over low-quality store brands are service independent.* However, the price premia involving the high-quality store brand follow a more complex pattern. However, we are able to provide sufficient conditions that ensure that both  $p_N^{S*} - p_H^{S*}$  and  $p_H^{S*} - p_L^{S*}$  are positive. They require not too large differences in service quality, i.e.  $x_D < x_S < 2x_D$ , and large enough differences between  $b_H$  and  $b_L$  and between  $b_N$  and  $b_L$  with close enough  $b_N$  and  $b_H$ . Price premium expressions and proofs are in the Appendix 3.

*Result 2: If  $1 + e < d + f$ , then the comparative statics for the supermarket price premia are*

	$b_N$	$b_H$	$b_L$	$x_S$	$x_D$	$w_N$	$c_H$	$c_L$
$p_N^{S*} - p_H^{S*}$	+	-	+	-	+	+	-	-
$p_H^{S*} - p_L^{S*}$	-	+	-	+	-	+	+	-
$p_N^{S*} - p_L^{S*}$	+	0	-	0	0	+	0	-

while  $\text{sign } \frac{\partial(p_N^{S*} - p_H^{S*})}{\partial x_S} = \text{sign } \frac{\partial(p_H^{S*} - p_L^{S*})}{\partial x_D} > 0$  and  $\text{sign } \frac{\partial(p_N^{S*} - p_H^{S*})}{\partial x_D} = \text{sign } \frac{\partial(p_H^{S*} - p_L^{S*})}{\partial x_S} < 0$  otherwise.

Noting that  $p_N^{D*} - p_L^{D*}$  follows the same comparative statics than  $p_N^{S*} - p_L^{S*}$ , the above result discloses an interesting conclusion: service quality is a strategic tool that can be used to target the usual customers of the leading national brand, since it closes the gap between national and high-quality store brands. At the same time, increases the gap between store brands within supermarkets to make more attractive the low-quality store brand for consumers that look for low prices. It is also important to underline that the supermarket level of service has the same effect on price premia as the high-quality store brand level of quality though the former is better controlled than the latter by the supermarket.

### 3 The econometric model and the data

#### 3.1 Database description

The data used to test our theoretical model are prices directly collected by the author in three stores in the south of Coventry (United Kingdom). Two of them, Tesco and Sainsbury's, belong to the two supermarket chains with the largest market share in the UK (at the time of data collection) and the third belongs to Kwik Save, the largest discounter chain.<sup>12</sup> Tesco and Kwik Save stores considered are located in Cannon Park shopping center and Sainsbury's is located approximately one and a half mile from them.<sup>13</sup>

The data set is composed of 27 price observations for the leading national brand, the high-quality and the low-quality store-brand variants of 46 products taken from November 1995 to March 1997 on a fortnightly basis (bar Christmas periods).

The criteria used to select the products for the sample are the following: (i) they should be present in the grocery of the representative UK consumer; and (ii) they should be available in three stores considered in the sample. Usually low-quality store brands are available in only one size and this is the size that we use for the analysis. The list of products used in the analysis can be found in the Appendix 2.

#### 3.2 Characterising supermarkets and discounters

The supermarket outlets considered in our analysis (belonging to the Tesco's and Sainsbury's chains) correspond to the superstore format. With a floor space over 25,000 square feet and located out of town, these superstores sell a large range of food and non-food products. The discounter outlets with a floor space between 6,000 and 12,000 square feet sell also a range of food and non-food products but more limited in size than the supermarket range.

Supermarkets and discounters differ in the level of service-quality they offer. The first element determining this difference in service-quality is the shopping environment. Supermarkets offer a nice shopping atmosphere with wide aisles, tidy shelves and big number of check-out lines to assure short queuing times and convenience. In contrast, in Kwik Save aisles are narrower, products are just piled up on the shelves, the number of check-outs is small and queues are frequent, etc. Supermarkets accept all major debit and credit cards whilst Kwik Save only accepts some of them. Supermarkets offer loyalty cards with accumulable points that later on will be transformed in monetary discounts, and the

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<sup>12</sup>Kwik Save became part of the Somerfield group in 1998. Then, in February 2006, it was sold to an investment firm and finally, it exit the market in July 2007.

<sup>13</sup>Cannon Park Shopping Centre included a few small shops, a pharmacy from a national chain, Tesco and Kwik Save.

possibility of using them in the own supermarket petrol station. Supermarkets also offer banking services and the possibility of home shopping via Internet. Supermarkets offer wider opening hours. Finally and more importantly, supermarkets offer a larger range of products making possible the desired one-stop shopping and reducing in this way the cost of shopping in terms of time. Therefore, service quality is higher for supermarkets than for discounters.

Supermarkets and discounters also differ in the rank of quality variants sold. Large UK supermarkets chains such as Tesco or Sainsbury sell three quality variants for most of the products they sell. From higher to lower quality they are national brands (manufacturer-branded products), high-quality store-brands, and low-quality store-brands.<sup>14</sup> Discounters as Kwik Save only sell national brands and low-quality store-brands (i.e. they do not sell the intermediate quality).

The national brands sold under the manufacturer's brand name are marketed under intense manufacturer advertising and product development, and are provided with identical specifications to all the retailers (e.g. Heinz Baked Beans). Therefore, we assume  $b_N$  to be the same for all the retailers considered.

UK supermarkets introduced high-quality store-brands more than 30 years ago to compete directly with the national brands. These products are located on shelves very close to the national brands and tend to mimic very closely their packaging and presentation (Corstjens and Corstjens, 1995). They are sold under each supermarket brand name: Tesco and Sainsbury's (for example, Tesco Baked Beans and so on).

The low-quality store-brand products (the lowest quality variant) were introduced in UK supermarkets from 1993 onwards. Their development was a reaction to the arrival in the UK of Continental discounters that offered a limited range of tertiary brand products sold at very reduced prices. The products of this quality variant can be characterized as basic products of manifestly lower quality that are sold at very low prices. Supermarkets have tried to avoid sales cannibalisation between the two store-brand variants by means of differentiation. Specifically, the two supermarkets sell high and low-quality store brands under different brand names and with completely different packaging. Whereas the high-quality store-brands are sold just under the supermarket brand name, the low-quality store-brands combine the supermarket denomination with another word that suggests their basic characteristics: Tesco Value or Sainsbury Essentials. In addition, whilst high-quality store-brand products packaging mimics that of the manufacturers' branded products, the packaging of the low-quality store-brands reflects the "value-for-money" approach that

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<sup>14</sup>This two-tier store brand strategy is not unique to UK supermarkets, Steiner (2004) also identifies it for Wal-Mart in the US.

supermarkets pursue with them. The very nature of this quality variant precludes any possibility of outlet differentiation. Consequently, we assume  $b_H$  and  $b_L$  should be the same for all the retailers.

### 3.3 Analysis of service-quality and brand-quality price premia

#### 3.3.1 Introduction

To test price premia we use the following reduced form equation:

$$p_{j,it}^r = \beta_0 + \beta_1 D_T + \beta_2 D_S + \beta_3 D_T \times D_H + \beta_4 D_S \times D_H + \beta_5 D_N + \beta_6 D_T \times D_N + \beta_7 D_S \times D_N + \varepsilon_{it}$$

where,

$$p_{j,it}^r = \frac{P_{j,it}^r}{P_{L,it}^{KwikSave}},$$

i.e. all prices are expressed as a ratio with respect to the price of the low-quality store brand in the low service quality retailer (Kwik Save).  $r$  denotes retailer: Tesco ( $T$ ), Sainsbury's ( $S$ ), KwikSave ( $K$ );  $j$  denotes quality variant: (national-brand ( $N$ ), high-quality store brand ( $H$ ), low-quality store brand ( $L$ ));  $i = 1, \dots, 46$  denotes products, and  $t = 1, \dots, 27$  denotes fortnights.

As for the variable definition,  $D_T$  is a dummy variable that takes value 1 if the price observation corresponds to Tesco and 0 otherwise;  $D_S$  is a dummy variable that takes value 1 if the price observation corresponds to Sainsbury's and 0 otherwise;  $D_H$  is a dummy variable that takes value 1 if the price observation corresponds to a high-quality store brand;  $D_N$  is a dummy variable that takes value 1 if the price observation corresponds to a national brand; and where  $\gamma_i$  are the individual effects that are considered as random effects, and  $\varepsilon_{it}$  is the error term.

By construction,  $\beta_0 + \beta_1$  is the mean relative price of Tesco low-quality store-brands,  $\beta_0 + \beta_2$  is the mean relative price of Sainsbury low-quality store-brands.<sup>15</sup> Analogously,  $\beta_0 + \beta_1 + \beta_3$  is the mean relative price of Tesco high-quality store-brands and  $\beta_0 + \beta_2 + \beta_4$  is the mean relative price of Sainsbury high-quality store-brands. Finally,  $\beta_0 + \beta_5$  is the mean relative price of Kwik Save national brands,  $\beta_0 + \beta_1 + \beta_5 + \beta_6$  is the mean relative price of national brands sold by Tesco, and  $\beta_0 + \beta_2 + \beta_5 + \beta_7$  is the mean relative price of national brands sold by Sainsbury's. Further, we can calculate mean price differentials among retailers for each of three brand qualities, and mean price differentials between

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<sup>15</sup>By construction  $\beta_0$ , the mean relative price of Kwik Save low-quality store-brands is equal to 1 as the reference price is always the price of Kwik Save low-quality store-brand.

brand qualities for each of the retailers. Table 1 shows the expressions used to calculate these differentials.

Table 1: Price differentials

<i>Between retailers for each brand quality</i>		
	National brands	High-quality Store brand
T-K	$\Delta_N^{T-K} = \beta_1 + \beta_6$	$\Delta_L^{T-K} = \beta_1$
S-K	$\Delta_N^{S-K} = \beta_2 + \beta_7$	$\Delta_L^{S-K} = \beta_2$
S-T	$\Delta_N^{S-T} = \beta_2 + \beta_2 - (\beta_1 + \beta_6)$	$\Delta_H^{S-T} = \beta_4 - \beta_3$
		$\Delta_L^{S-T} = \beta_2 - \beta_7$
<i>Between quality brands for each retailer</i>		
	Kwik-Save	Tesco
N-L	$\Delta_{N-L}^K = \beta_5$	$\Delta_{N-L}^T = \beta_5 + \beta_6$
		$\Delta_{N-L}^S = \beta_5 + \beta_7$
N-H		$\Delta_{N-H}^T = \beta_5 + \beta_6 - \beta_3$
		$\Delta_{N-H}^S = \beta_5 + \beta_7 - \beta_4$
H-L		$\Delta_{H-L}^T = \beta_3$
		$\Delta_{H-L}^S = \beta_4$

### 3.3.2 Service-quality premium estimation

We calculate the service-quality premium of supermarket  $r$  over Kwik-Save for brand-quality  $k$  as the ratio of the mean price differential between supermarket  $r$  and Kwik-Save ( $\Delta_j^{r-K}$ , as defined in Table 1) over the mean price at Kwik Save (for  $r = T, S$  and  $j = N, L$ ).<sup>16</sup>

Such as they are calculated each of the service-quality premia can be interpreted as the average percentage price increase for brand quality  $k$  at a high service quality retailer over the price at the low-service quality retailer due to a higher service quality level., e.g. the average service-quality premium of Tesco for national brands is the average price increase of national brands at Tesco with respect to the price of the national brands at Kwik-Save.

Our theoretical model offers two testable implications on service-quality premia: first,

<sup>16</sup>As Kwik Save only offers the two extreme quality variants (national brands and low-quality store-brands) we cannot calculate service quality differentials for high-quality store-brands.



for a given brand-quality the service-quality premium should be the same for all super-markets; second, for each retailer the service-quality premium should be brand-quality independent (i.e. service quality premium should be the same for national brands and low-quality store-brands).

To investigate the first implication, we need to estimate the service-quality premia of Tesco and Sainsbury's for national brands and low-quality store-brands. Additionally, we test for differences between Tesco and Sainsbury's price premia both for national brands and low-quality store brands. This involves to test whether  $\frac{\Delta_j^{T-S}}{p_j^S}$  for  $j = N, L$  is significantly different from zero.

The estimates of service-quality premia for national brands (shown in Table 2) suggest that the average service-quality premia enjoyed by Tesco and Sainsbury's (over Kwik-Save) for this brand-quality is about 6% (both  $\hat{\Delta}_N^{T-K}$  and  $\hat{\Delta}_N^{S-K}$  are significant and about 0.06). Further,  $\hat{\Delta}_N^{T-S}$  is not significant suggesting that for this brand quality there is no difference between the average service-quality premium enjoyed by the two high service-quality retailers over Kwik-Save.

Our estimates suggest that the average service-quality premium for low-quality store-brands enjoyed by high service-quality retailers ranks between 9.2 and 15.4% (for Tesco and Sainsbury's, respectively). Additionally,  $\hat{\Delta}_L^{T-S}$  is not significant (at a conventional 5% level) suggesting that for this brand-quality there is not difference between the average service-quality premia of the two high service-quality retailers.

Table 2: Estimates for service quality premia

	National brand	Low-quality store brand
$T-K$	$\hat{\Delta}_N^{T-K} = \frac{\hat{\beta}_1 + \hat{\beta}_6}{\hat{\beta}_0 + \hat{\beta}_5} = 0.058^{***}$	$\hat{\Delta}_L^{T-K} = \frac{\hat{\beta}_1}{\hat{\beta}_0} = 0.092^{***}$
$S-K$	$\hat{\Delta}_N^{S-K} = \frac{\hat{\beta}_2 + \hat{\beta}_7}{\hat{\beta}_0 + \hat{\beta}_5} = 0.060^{***}$	$\hat{\Delta}_L^{S-K} = \frac{\hat{\beta}_2}{\hat{\beta}_0} = 0.154^{***}$
$S-T$	$\hat{\Delta}_N^{S-T} = \frac{\hat{\beta}_2 + \hat{\beta}_7 - (\hat{\beta}_1 + \hat{\beta}_6)}{\hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_5 + \hat{\beta}_6} = 0.002$	$\hat{\Delta}_L^{S-T} = \frac{\hat{\beta}_2 - \hat{\beta}_1}{\hat{\beta}_0 + \hat{\beta}_1} = 0.058^*$
* Significant at 10%; ** Significant at 5%; *** Significant at 1%		

Further, to test whether service-quality premium is brand quality independent, we estimate the following *differentials-in-premium*:  $dip^{T-K} = \Delta_N^{T-K} - \Delta_L^{T-K} = \frac{\beta_1 + \beta_6}{\beta_0 + \beta_5} - \frac{\beta_1}{\beta_0}$  and  $dip^{S-K} = \Delta_N^{S-K} - \Delta_L^{S-K} = \frac{\beta_2 + \beta_7}{\beta_0 + \beta_5} - \frac{\beta_2}{\beta_0}$ . They allow comparing average service-quality premia of national brands and low-quality store-brands for Tesco and Sainsbury, respectively. Our estimates confirm the quality-variant independence of service-quality premia for Tesco ( $\widehat{dip^{T-K}} = -0.034$  is not significant). However, for Sainsbury's the

service-quality premium of low-quality store brands is 9% higher than that of national brands (  $\widehat{dip^{S-K}}$  and corresponding p-value are  $-0.095$  and  $0.007$ , respectively).

### 3.3.3 Brand-quality premium estimation

We calculate the brand-quality premium of brand quality  $j$  over brand quality  $k$  (with  $j \neq k$ ) at retailer  $r$  as the ratio of the mean price differential between brand qualities  $j$  and  $k$  ( $\Delta_{j-k}^r$ , as defined in Table 1) over the mean price of brand quality  $k$ , (for  $j = N, H$  and  $k = H, L$  and  $j \neq k$ ;  $r = T, S, K$ ). Such as they are calculated each of the brand-quality premia can be interpreted as the percentage price increase of the higher brand quality over the lower brand quality, e.g. the brand-quality premium of national brands over low-quality store brands is the average price increase of national brands with respect to the price of the low-quality store brand.

The estimates of the brand-quality premia of national brands over high and low-quality store brands, and high-quality store-brands over low-quality store brands are shown in Table 3. Our estimates suggest that the average premium of national brands over low-quality store brands ranks from 148% to 171% (e.g at Sainsbury's on average prices of national brands are 148% higher than those of low-quality store brands). Additionally, between supermarkets pairwise comparisons reveal that the average premium of national-brands over low-quality store brands is not service-quality dependent, as average premium is higher at Tesco and Kwik Save (two retailers with different levels of service quality) than at Sainsbury's (  $\hat{\Delta}_{N-L}^S - \hat{\Delta}_{N-L}^T = 0.138$  with p-value 0.008;  $\hat{\Delta}_{N-L}^T - \hat{\Delta}_{N-L}^K = -0.084$  with p-value 0.323;  $\hat{\Delta}_{N-L}^S - \hat{\Delta}_{N-L}^K = -0.222$  and with p-value 0.043).

The estimated average premium of national brands over high-quality store ranks from 38% at Tesco to 40% at Sainsbury's, and there is no significant difference between average premia across retailers (  $\hat{\Delta}_{N-H}^T - \hat{\Delta}_{N-H}^S = 0.021$  with p-value 0.432). Finally, the estimated average premium of high-quality store brands over low-quality store brands ranks from 80% at Sainsbury to 87.6% at Tesco: However, this difference between average premium is not statistically significant (  $\hat{\Delta}_{H-L}^T - \hat{\Delta}_{H-L}^S = 0.072$  with p-value 0.233).

Table 3: Estimates for brand-quality premia

	$K$	$T$	$S$
$N-L$	$\hat{\Delta}_{N-L}^K = \frac{\hat{\beta}_5}{\hat{\beta}_0} = 1.708^{***}$	$\hat{\Delta}_{N-L}^T = \frac{\hat{\beta}_5 + \hat{\beta}_6}{\hat{\beta}_0 + \hat{\beta}_1} = 1.624^{***}$	$\hat{\Delta}_{N-L}^S = \frac{\hat{\beta}_5 + \hat{\beta}_7}{\hat{\beta}_0 + \hat{\beta}_2} = 1.485^{***}$
$N-H$		$\hat{\Delta}_{N-H}^T = \frac{\hat{\beta}_5 + \hat{\beta}_6 - \hat{\beta}_3}{\hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_3} = 0.398^{***}$	$\hat{\Delta}_{N-H}^S = \frac{\hat{\beta}_5 + \hat{\beta}_7 - \hat{\beta}_4}{\hat{\beta}_0 + \hat{\beta}_2 + \hat{\beta}_4} = 0.377^{***}$
$H-L$		$\hat{\Delta}_{H-L}^T = \frac{\hat{\beta}_3}{\hat{\beta}_0 + \hat{\beta}_1} = 0.876^{***}$	$\hat{\Delta}_{H-L}^S = \frac{\hat{\beta}_4}{\hat{\beta}_0 + \hat{\beta}_2} = 0.804^{***}$
* Significant at 10%; ** Significant at 5%; *** Significant at 1%			

## 4 Conclusions

Markets sell different varieties of products in different stores. Consumers have, therefore, several alternatives to satisfy their needs. Depending on their tastes they will be willing to buy either leading branded products (i.e. national brands) or low-quality store brands and they might also have different willingness to pay for those products purchased at retailers that offer high-quality service. As a consequence a plethora of prices can be found for the "same" good. We develop a theoretical model of retail competition that include two sources of quality, one inherently linked to brand characteristics and the other linked to the retailer level of service and then measure their contribution in explaining the observed price differentials for a sample of U.K. grocery retailer prices collected by one of the authors in three stores in the south of Coventry (United Kingdom) during the period starting November 1995 and ending March 1997. We find that at equilibrium the retailers that offer a higher quality service sell same quality brands at higher prices. These price premia are explained solely by differences in service quality levels. We find econometric evidence that they amount to 6% for national brands and to a range between 9% and 15% for low-quality store brands. Besides, at a given store, the price premia paid for the national brand is positive. These differentials are very large: around 150% between national brands and low-quality store brands, around 40% between national brands and high-quality store brands. Also, the price differential between the national brand and the low-quality store brand for retailers with broader product range does not increase with its service quality. Besides, the price of the high-quality store brand approaches the price of the national brand when service quality increases. Thus suggesting that stores that offer high quality service uses the level of service as an strategic tool to target the leading national brand consumers.

## Appendix 1. Estimation results

<i>Table A1: Estimation Results</i>		
	Coefficient	p-value
Constant	1	0.000
$D_T$	0.092	0.004
$D_S$	0.155	0.000
$D_T \times D_H$	0.957	0.000
$D_S \times D_H$	0.929	0.000
$D_N$	1.708	0.000
$D_T \times D_N$	0.065	0.153
$D_S \times D_N$	0.008	0.866
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<i>Number of observations:</i>	9936	
$R^2$ :	0.348	

## Appendix 2: List of products:

Baked Beans in Tomato Sauce 425grs	Orange Juice 1 litre
Beer 330ml	Oven Chips 1810grs
Bleach 2 litres	Pasta Sauce 475grs
Canned Peas 400grs	Pasta Sauce 475grs
Canned Spaghetti 200grs	Peach Halves in Syrup 415grs
Canned Sweet Corn 340grs	Salad Dressing 285grs
Canned Tomatoes 400grs	Salted Crisps (Multipack. 6 packs)
Cat Food 400grs can	Sanitary Towels (16 units)
Cola 2 litres	Shower Gel 500ml
Conditioner 2 litres	Smoked Back (8 slices)
Cornflakes 500grs	Soap 250grs
Deodorant 150ml	Spaghetti 500grs
Dog Food 400grs can	Strawberry Jam 454 grs
Fish Fingers (10 units)	Strawberry Yoghurt 200grs
Flour 1.5kg	Tea 250grs
Frozen Peas 340grs can	Tissues (90 units)
Hair Shampoo 400grs	Toilet Roll 4 rolls pack
Instant Coffee 200grs	Toothpaste 100ml
Ketchup 340grs	Tuna in Oil 200grs can
Kitchen Foil 450mm x 5m	Vanilla Ice Cream 750grs
Kitchen Towel (2 rolls pack)	Washing Powder 2kgs
Long Grain Rice 1kg	Washing Up Liquid 500ml
Margarine 500grs	White Bread 800grs
Mayonnaise 400grs	

## Appendix 3. Equilibria and proofs

### -First Order Conditions, Second Order Conditions and Equilibrium Outputs.

The system of first order conditions can be written as  $\hat{\alpha} = Aq$ , or in a expanded way,

$$\begin{pmatrix} \alpha_N^S - w_N \\ \alpha_H^S - c_H \\ \alpha_L^S - c_L \\ \alpha_N^D - w_N \\ \alpha_L^D - c_L \end{pmatrix} = \begin{pmatrix} 2 & 2d & 2e & 1 & e \\ 2d & 2 & 2f & d & f \\ 2e & 2f & 2 & e & 1 \\ 1 & d & e & 2 & 2e \\ e & f & 1 & 2e & 2 \end{pmatrix} \begin{pmatrix} q_N^S \\ q_H^S \\ q_L^S \\ q_N^D \\ q_L^D \end{pmatrix}.$$

By inverting  $A$ , we obtain the following symmetric matrix:

$$A^{-1} = \left( \frac{1}{6\Lambda\tau} \right) \begin{pmatrix} -\Lambda - 3\tau(1-f^2) & 3\tau(d-ef) & e\Lambda + 3\tau(e-df) & 2\Lambda & -2e\Lambda \\ 3\tau(d-ef) & 3\tau^2 & 3\tau(f-ed) & 0 & 0 \\ e\Lambda + 3\tau(e-df) & 3\tau(f-ed) & -\Lambda - 3\tau(1-d^2) & -2e\Lambda & 2\Lambda \\ 2\Lambda & 0 & -2e\Lambda & -4\Lambda & 4e\Lambda \\ -2e\Lambda & 0 & 2\Lambda & 4e\Lambda & -4\Lambda \end{pmatrix},$$

where  $\Lambda \equiv -1 - 2def + d^2 + f^2 + e^2$  and  $\tau \equiv -1 + e^2$ . The equilibrium vector is therefore defined as  $q^* = A^{-1}\hat{\alpha}$ .

The equilibrium outputs expressions as a function of all parameters, i.e.  $b_N, b_H, b_L, x_S, x_D, w_N, c_H, c_L$ , are

$$\begin{aligned} q_N^{S*} &= \frac{[\Lambda - 3\tau(1-f^2)](b_N - w_N) + 3\tau(d-ef)(b_H - c_H) + [-e\Lambda + 3\tau(e-df)](b_L - c_L)}{6\Lambda\tau} \\ &\quad + \frac{-[(1-e)\Lambda + 3\tau(1-f)(1+f-(d+e))]x_S + 2(1-e)\Lambda x_D}{6\Lambda\tau} \\ q_H^{S*} &= \frac{3\tau(d-ef)(b_N - w_N) + 3\tau^2(b_H - c_H) + 3\tau(f-de)(b_L - c_L) + 3\tau(1-e)(d+f-(1+e))x_S}{6\Lambda\tau} \\ q_L^{S*} &= \frac{[-e\Lambda + 3\tau(e-df)](b_N - w_N) + 3\tau(f-de)(b_H - c_H) + [\Lambda - 3\tau(1-d^2)](b_L - c_L)}{6\Lambda\tau} \\ &\quad + \frac{-[(1-e)\Lambda + 3\tau(1-d)(1+d-(f+e))]x_S + 2(1-e)\Lambda x_D}{6\Lambda\tau} \\ q_N^{D*} &= \frac{-2\Lambda(b_N - w_N) + 2e\Lambda(b_L - c_L) + 2(1-e)\Lambda x_S - 4(1-e)\Lambda x_D}{6\Lambda\tau} \\ q_L^{D*} &= \frac{2e\Lambda(b_N - w_N) - 2\Lambda(b_L - c_L) + 2(1-e)\Lambda x_S - 4(1-e)\Lambda x_D}{6\Lambda\tau}. \end{aligned}$$

In order to deal with second order conditions for a maximum, let us define  $T_S$  and  $T_D$  as follows,

$$T_S = \begin{pmatrix} -2 & -2d & -2e \\ -2d & -2 & -2f \\ -2e & -2f & -2 \end{pmatrix}, \quad T_D = \begin{pmatrix} -2 & -2e \\ -2e & -2 \end{pmatrix}.$$

-The second order conditions for the Supermarket are that  $T_S$  be definite negative. This is equivalent to the following conditions: i)  $1 > d^2$ , ii)  $1 > f^2$ , iii)  $1 > e^2$  and iv)  $\det T_S = \Lambda < 0$ .

-The second order conditions for the Discounter are that  $T_D$  be definite negative, that is,  $\det T_S = -\tau > 0$ .

### -Equilibrium Outputs Comparative Statics.

a) Comparative statics for  $q_N^{S*}$ .

a.i)  $\text{sign} \frac{\partial q_N^{S*}}{\partial (b_N - w_N)} = \text{sign}(\Lambda - 3\tau(1 - f^2))$  which is positive since  $\Lambda$  can be written as  $\tau(1 - f^2) + (d - fe)^2$ , therefore,  $\Lambda - 3\tau(1 - f^2) = -2\tau(1 - f^2) + (d - fe)^2 > 0$ .

a.ii)  $\text{sign} \frac{\partial q_N^{S*}}{\partial (b_H - c_H)} = \text{sign}(\tau(d - fe))$  which is negative since  $d > fe$  and  $\tau < 0$ .

a.iii)  $\text{sign} \frac{\partial q_N^{S*}}{\partial (b_L - c_L)} = \text{sign}(-e\Lambda + 3\tau(e - df))$ . A sufficient condition for  $\frac{\partial q_N^{S*}}{\partial (b_L - c_L)}$  to be positive is  $e < df$ . This is always true if  $1 + e < f + d$ . Note that  $f + d < 1 + df$  and therefore  $1 + e < f + d < 1 + df$ , which yields the result. However, for  $df < e < f$ , in order to get a positive sign we need  $-\Lambda > -3\tau(1 - \frac{df}{e})$ .

a.iv)  $\text{sign} \frac{\partial q_N^{S*}}{\partial x_S} = \text{sign}(-(1 - e)\Lambda - 3\tau(1 - f)(1 + f - (d + e)))$  which is positive since  $1 + f > d + e$ .

a.v)  $\text{sign} \frac{\partial q_N^{S*}}{\partial x_D} = \text{sign}((1 - e)\Lambda) < 0$ .

b) Comparative statics for  $q_H^{S*}$ .

b.i)  $\text{sign} \frac{\partial q_H^{S*}}{\partial (b_N - w_N)} = \text{sign} \frac{\partial q_N^{S*}}{\partial (b_H - c_H)} < 0$ .

b.ii)  $\text{sign} \frac{\partial q_H^{S*}}{\partial (b_H - c_H)} = \text{sign}(\tau^2) > 0$ .

b.iii)  $\text{sign} \frac{\partial q_H^{S*}}{\partial (b_L - c_L)} = \text{sign}(\tau(f - de))$  which is negative since  $f > de$  and  $\tau < 0$ .

b.iv)  $\text{sign} \frac{\partial q_H^{S*}}{\partial x_S} = \text{sign}(\tau(1 - e)(d + f - (1 + e)))$  which is positive if  $d + f < 1 + e$ , zero if  $d + f = 1 + e$ , negative otherwise.

c) Comparative statics for  $q_L^{S*}$ .

c.i)  $\text{sign} \frac{\partial q_L^{S*}}{\partial (b_N - w_N)} = \text{sign} \frac{\partial q_N^{S*}}{\partial (b_L - c_L)}$ .

c.ii)  $\text{sign} \frac{\partial q_L^{S*}}{\partial (b_H - c_H)} = \text{sign} \frac{\partial q_H^{S*}}{\partial (b_L - c_L)} < 0$ .

c.iii)  $\text{sign} \frac{\partial q_L^{S*}}{\partial (b_L - c_L)} = \text{sign}(\Lambda - 3\tau(1 - d^2))$  which is positive since  $\Lambda$  can be written as  $\tau(1 - d^2) + (f - de)^2$ , therefore,  $\Lambda - 3\tau(1 - d^2) = -2\tau(1 - d^2) + (f - de)^2 > 0$ .

c.iv)  $\text{sign} \frac{\partial q_L^{S*}}{\partial x_S} = \text{sign}(-(1 - e)\Lambda - 3\tau(1 - d)(1 + d - (f + e)))$  which is positive

since  $1 + d > f + e$ .

$$\text{c.v) } \text{sign} \frac{\partial q_L^{S*}}{\partial x_D} = \text{sign} \frac{\partial^* q_{NS}}{\partial x_D} < 0.$$

d) Comparative statics for  $q_N^{D*}$  and  $q_L^{D*}$

$$\text{d.i) } \text{sign} \frac{\partial q_N^{D*}}{\partial (b_N - w_N)} = \text{sign} \frac{\partial q_L^{D*}}{\partial (b_L - c_L)} = \text{sign} (-\Lambda) > 0.$$

$$\text{d.ii) } \text{sign} \frac{\partial q_N^{D*}}{\partial (b_L - c_L)} = \text{sign} \frac{\partial q_L^{D*}}{\partial (b_N - w_N)} = \text{sign} (e\Lambda) < 0.$$

$$\text{d.iii) } \text{sign} \frac{\partial q_N^{D*}}{\partial x_S} = \text{sign} \frac{\partial q_L^{D*}}{\partial x_S} = \text{sign} ((1 - e)\Lambda) < 0.$$

$$\text{d.iv) } \text{sign} \frac{\partial q_N^{D*}}{\partial x_D} = \text{sign} \frac{\partial q_L^{D*}}{\partial x_D} = \text{sign} (-(1 - e)\Lambda) > 0.$$

-Price margins, price premia and conditions for positive price premia.

### Supermarket

-Price margins:

$$\begin{aligned} p_N^{S*} - w_N &= \frac{b_N - w_N + 2x_S - x_D}{3} \\ p_H^{S*} - c_H &= \frac{b_H - c_H}{3} + \frac{x_S}{2} + \frac{(d - fe)(b_N - w_N) + (f - de)(b_L - c_L)}{6\tau} + \frac{(1 - e)(d + f)(2x_D - x_S)}{6\tau} \\ p_L^{S*} - c_L &= \frac{b_L - c_L + 2x_S - x_D}{3} \end{aligned}$$

-Price premia:

$$\begin{aligned} p_N^{S*} - p_H^{S*} &= \frac{-b_H - 2c_H + 3w_N}{3} + \frac{(2\tau - (d - fe))(b_N - w_N) - (f - de)(b_L - c_L)}{6\tau} + \frac{(1 - e)(d + f - 1 - e)(x_S - 2x_D)}{6\tau} \\ p_H^{S*} - p_L^{S*} &= \frac{b_H + 2c_H + 3c_L}{3} + \frac{(d - fe)(b_N - w_N) + (-2\tau + (f - de))(b_L - c_L)}{6\tau} - \frac{(1 - e)(d + f - 1 - e)(x_S - 2x_D)}{6\tau} \\ p_N^{S*} - p_L^{S*} &= \frac{b_N - b_L + 2(w_N - c_L)}{3} \end{aligned}$$

First,  $p_N^{S*} - p_L^{S*}$  is positive since  $b_N > b_L$  and  $w_N > c_L$ . Regarding the other two price premia, we have that  $p_N^{S*} - p_H^{S*} > 0$  if and only if

$$\frac{x_S - x_D}{3} - \frac{(1 - e)(d + e)(2x_D - x_S)}{6\tau} > \frac{2\tau(b_H - c_H) - (2\tau - (d - fe))(b_N - w_N) + (f - de)(b_L - c_L)}{6\tau} - (w_N - c_H)$$

Similarly,  $p_H^{S*} - p_L^{S*} > 0$  if and only if,

$$\frac{x_S - x_D}{3} - \frac{(1 - e)(d + e)(2x_D - x_S)}{6\tau} < \frac{2\tau(b_H - c_H) + (d - fe)(b_N - w_N) - (2\tau - (f - de))(b_L - c_L)}{6\tau} + (c_H - c_L)$$



The above two expressions define an interval for  $\frac{x_S - x_D}{3} - \frac{(1-e)(d+e)(2x_D - x_S)}{6\tau}$ , which entails the levels of quality service. For this expression to be positive, it is sufficient that  $x_D < x_S < 2x_D$ . Also, note that the interval always exists if  $b_N > b_L$  and  $w_N > c_L$ . Finally, we only need to ensure that the upperbound is positive. That is,

$$b_H > \frac{(d - fe)(b_N - w_N) + (f - de)(b_L - c_L)}{-6\tau} + b_L.$$

There only remains to check that  $\frac{(d-fe)(b_N-w_N)+(f-de)(b_L-c_L)}{-6\tau} + b_L < b_N$ . But this is true if and only if  $b_N$  is large enough with respect to  $b_L$ , that is for

$$b_N > \left( \frac{-6\tau + (f - de)}{-6\tau - (d - fe)} \right) b_L - \frac{(d - fe)w_N + (f - de)c_L}{-6\tau - (d - fe)}.$$

Summarizing, we require not too large differences in service quality, i.e.  $x_D < x_S < 2x_D$ , and large enough differences between  $b_H$  and  $b_L$  and between  $b_N$  and  $b_L$  with close enough  $b_N$  and  $b_H$ .

## Discounter

-Price margins and price premium:

$$\begin{aligned} p_N^{D*} - w_N &= \frac{b_N - w_N + 2x_D - x_S}{3} \\ p_L^{D*} - c_L &= \frac{b_L - c_L + 2x_D - x_S}{3} \\ p_N^{D*} - p_L^{D*} &= \frac{b_N - b_L + 2(w_N - c_L)}{3}. \end{aligned}$$

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